RESEARCH PROGRESS REPORT

Program: **VDACS – Specialty Agriculture Research Grant – FY06**

Project Title: **Development and Management of Specialty Small Grain Varieties for High-Value End-Use Markets**

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Project Component: Breeding & Development of Specialty Wheat Varieties

The small grains breeding program initiated research focused on the evaluation and development of specialty wheat in 1998. One objective of the program has been to identify and develop soft wheat lines with high-value traits such as white seed color and unique protein quality (strong gluten strength). Another major objective has been to identify and develop hard wheat lines adapted to our region. We continue to interact with producers and millers in Virginia and the region in order to identify and incorporate desirable and high value end-use traits into adapted wheat varieties. During May 2006, a personal tour of Bread Wheat Breeding Nurseries was given to C.J. Lin (Research Director of Mennel's Roanoke City Mill), Don Mennel (President and CEO of Mennel Milling Co.), Michael Barnett (Quality Assurance Manger of Miller Milling Co., Winchester, VA), and three representatives of Gerards Custom Bread Co. including Gary Knight (President and CEO). Grain samples of specialty wheat lines are provided to millers for milling and baking evaluations each year, thereby directly identifying wheat lines having desirable end-use quality that have potential commercial production and/or use as parents in the breeding program.

Analysis of agronomic and milling and baking quality data of entries evaluated in Virginia Tech's Bread Wheat Yield Nurseries since 2003 indicate that the released Hard White Winter (HWW) wheat variety Lakin and the Hard Red Winter (HRW) wheat varieties TAM 110 and TAM 302 have potential for commercial production in the mid-Atlantic region. The HRW wheat experimental lines 92PAN2#26, KS00F5-58-3, KS00F5-20-3-2 and TX99D4478, and the French bread wheat line SX1432W also have performed well in both agronomic and quality tests. Breeder seed of KS00F5-20-3-2 is currently being developed and a small seed increase will be harvested by VCIA this summer. Breeder seed of TX99D4478 is currently being developed at NCSU by USDA-ARS. Breeder seed of 92PAN2#26 and KS00F5-58-3 will be provided to VCIA this fall for producing an initial seed increase. Such hard wheat varieties will provide producers with an alternative to the currently grown French variety Soissons until superior varieties are released from breeding programs at Virginia Tech and elsewhere.

Factors limiting small grains production during the past several years add credence to the need to develop and select hard wheat varieties that are adapted to our region. The 2002-03 growing season was likely the worst in the past decade for small grains production and was plagued by excessive precipitation from planting to harvest, which incited and resulted in significant losses in grain yield and quality due to head diseases such as Fusarium head blight (scab) and glume blotch. The 2003-04 growing season was unusual in that hot day time (>85 F) and evening temperatures occurred on more than 15 days in May during the critical grain fill period. These temperature extremes resulted in significant reductions in grain yield and test weight. Hard wheat and European wheat lines, developed in other states or countries, were particularly affected by these disease and environmental stresses primarily due to their lack of adaptation to our region.

Summary of Project Activities to Date

Approximately 235 bread wheat varieties and experimental lines developed by breeding programs in Colorado, Kansas, Nebraska, Oklahoma, South Dakota, Texas, and France as well as 115 bread wheat experimental lines developed at Virginia Tech are currently being evaluated for agronomic performance in yield trials at two to three locations in Virginia. Following harvest, data from field observations and post-harvest data including grain yield, test weight, and grain protein will be analyzed and superior lines will be selected for further testing during the 2006-07 season. Grain samples from selected elite lines will be sent to the Hard Wheat Quality Lab in Manhattan, KS for milling and baking quality analysis and also will be provided to one or more millers in Virginia for evaluation of end-use quality.

Bread Wheat Elite Trial

During the 2005-06 growing season, 4 strong gluten soft red winter (SRW) wheat lines, 21 hard red winter wheat lines, 3 French bread wheat lines, and 4 hard white bread wheat lines are currently being evaluated for agronomic performance in Virginia's Bread Wheat Elite Test at three locations.

Experimental Bread Wheat Test

Among the first 65 hard wheat lines selected in the breeding program at Virginia Tech, 15 HRW and 1 HWW wheat lines were selected for further testing and are currently being evaluated in replicated yield tests at two locations in 2006. Grain yields of the best lines were similar to those of the widely grown SRW wheat Tribute (78 – 80 bu/ac) in 2005. A grain sample composite over both locations was evaluated by Mennel Milling Company for milling and baking quality. Seven of the experimental lines received an overall quality score (4 – 4.5) that was similar to the HRW wheat quality check variety Jagger.

Bread Wheat Breeding & Population Advancement

In fall 2005, we planted 134 bread wheat breeding populations and 160 new F_1 populations derived from crosses made among bread wheat and/or strong gluten SRW wheat lines in spring 2005. More than 5800 headrows (progeny derived from a single wheat head and planted in a 4 ft row) derived from bread wheat populations are currently being evaluated in the field at Warsaw, VA from which selected headrows will be harvested and planted in observation yield plots in fall 2006. More than 100 new hard wheat lines selected from our program in 2005 are currently being evaluated in observation yield nurseries at two locations in 2006, and initial evaluation of these lines indicates that they are agronomically superior to most lines selected in 2005. In

addition, 32 advance wheat lines are being evaluated in replicated yield trials at three locations in our Bread Wheat Elite Test, and 35 wheat lines in the Uniform Regional Bread Wheat Nursery and 25 entries in the VT Bread Wheat Preliminary Nursery are being evaluated in replicated yield tests at two locations in 2006. During spring 2006, 105 new crosses were made among bread wheat and/or strong gluten SRW wheat lines. The program continues to evaluate new bread wheat lines including nearly 50 HRW wheat lines from both Kansas and Colorado breeding programs currently being evaluated in yield tests at Warsaw, VA. Many of these lines are used as parents in our crossing program.

Bread Wheat Seed Production Blocks Currently Being Grown at Warsaw, VA. Grain from these seed increase blocks will be provided to millers for quality testing and seed of elite lines 92PAN2#26 and KS00F5-58-3 will be provide to the Virginia Crop Improvement Association's Foundation Seed Farm for further increase in 2006-07.

Project Component: Breeding & Development of Hulless Barley Varieties

Purpose:

The proposed research is designed to improve the feed value of barley by developing hulless varieties that have a lower concentration of fiber, reduced phytic acid and higher metabolizable energy. This transformation should bring the nutritional value of barley closer to that of wheat and maize. In addition, development of hulless barley varieties having high-value traits, such as hulless seed, waxy endosperm, high or low beta glucan content (depending on end use) and low phytic acid content, is targeted at improving marketability of barley as a feed, food and fuel ingredient.

Specific Objectives:

The specific objectives of this project are: 1) to develop barley varieties with greater marketability in both domestic and foreign markets and, thereby, make barley an economical cash crop; and 2) to improve the end use value of barley by developing hulless varieties having lower concentrations of fiber and phytic acid and higher metabolizable energy.

Development and Evaluation of Hulless Barley Varieties:

To date, our program has developed more than 3,400 hulless winter barley populations. More than 225 hulless breeding populations and 335 pure lines are currently being evaluated for agronomic performance in field tests. Presently, we are evaluating 25 lines in our hulless advanced test, 48 lines in hulless preliminary test and 230 lines in observation yield tests. This season, (2005-2006), we are currently evaluating and will select pure lines among nearly 5,000 hulless headrows. Thirteen elite hulless lines are being evaluated in the 2006 Virginia State Variety Trials at six locations. An additional 73 advance hulless lines are being evaluated in nurseries grown at four locations in Virginia and at one or two locations in Kentucky, Delaware, Maryland, North Carolina and South Carolina.

Fifty-seven advanced hulled and hulless lines with good performance are being evaluated by the USDA-ARS Eastern Regional Research Center in Pennsylvania for chemical composition and other value-added traits. In addition, 6 samples of Doyce hulless barley grown in 2005 in six states are being analyzed to determine whether and to what extent environment affects chemical and nutritional composition of hulless barley.

This season (2005-2006), the second backcross progeny from crosses made between low phytic acid spring barley mutant lines will be assessed for phytic acid content and plants with low phytic acid will be backcrossed to their respective elite hulled or hulless parent. Phytic acid is the most abundant form of phosphorous (P) in seed and is indigestible in both human and non-ruminant livestock. Therefore, reducing the phytic acid content of hulless lines will indeed be useful in improving the nutritional value of barley fed to poultry and swine and potentially can reduce fecal-derived phosphorous pollution.

Hulless lines that are in the advanced stages of testing continue to show a great deal of promise with respect to agronomic performance. Many lines have improved straw strength and grain plumpness and are less susceptible to diseases (eg. leaf rust, powdery mildew, net blotch, and scald) in comparison to the original hulless lines from South Carolina. Seed of the hulless barley elite line VA01H-68 is currently being produced on over 5 acres at the Virginia Crop Improvement Association's Foundation Seed Farm in anticipation of its release and commercial production. This hulless barley line is superior to the variety Doyce in that it is earlier-maturing, has plumper grain of superior quality and threshes cleaner having better hull detachment.

Following harvest, data from field observations and post-harvest data including grain yield, test weight, and grain protein will be analyzed and superior lines will be selected for further testing during the 2006-

07 season. Grain samples from selected elite lines will be sent to the USDA-ARS Eastern Regional Research Center in Pennsylvania for analysis of chemical composition. Presentation of Virginia Tech's Hulless Barley Breeding Program at 2006 Warsaw Small Grains Field Day

Hulless Barley Seed Increase Blocks Currently Being Grown at the Eastern Virginia Agricultural Research and Extension Center, Warsaw, VA

Project Component: Hulless Barley Management

Summary of completed project activities:

Experiment: Appropriate seeding rate for hulled and hulless barley in Virginia
Timeline: Fall 2004 to Summer 2006

Hulless barley seeding rate trials were established at the Tidewater AREC and Eastern Virginia AREC in fall 2005. Germination tests were performed on all entries by the VDACS seed lab (Table 1). All plants in 0.9 m from the two center rows of each plot were counted prior to tillering to determine the number of plants m^{-2}. Comparison to seeding rate allows determination of percent emergence and an estimate of plant vigor (Table 2). The same area within each plot was evaluated for heads m^{-2} in May 2006. While increasing rates increased the number of plants for both hulled and hulless barley, the number of harvestable heads was optimized by seeding rates of 600 seeds m^{-2} for hulled barley and 700 seeds m^{-2} for hulless barley in 2006 (Table 2).

Germination of barley cultivars, 2005-06.

Cultivar	Hull Trait	Germination, %[†]
CALLAO	Hulled	99
DOYCE	Hulless	96
PRICE	Hulled	97
THOROUGHBRED	Hulled	92
VA00H-65	Hulless	97
VA01H-122	Hulless	93
VA01H-124	Hulless	96
VA01H-125	Hulless	97
VA01H-68	Hulless	96

[†]Determined by VDACS seed lab

Plants and heads per square meter, Holland and Warsaw, 2005-06.

	Warsaw				Holland			
	Hulled		Hulless		Hulled		Hulless	
Seeding rate								
seeds m^{-2}	heads m^{-2}	plants m^{-2}	heads m^{-2}	plants m^{-2}	heads m^{-2}	plants m^{-2}	heads m^{-2}	plants m^{-2}
278	434	253	492	210	523	226	549	143
371	455	308	510	277	578	279	561	163
464	521	407	527	326	541	330	533	212
557	553	450	631	416	566	387	576	232
649	631	633	605	456	621	380	632	269
742	603	707	734	521	627	443	626	290

323 seeds m^{-2} 646 seeds m^{-2}

Thoroughbred VA01H-68 Thoroughbred VA01H-68

Experiment: Optimizing spring nitrogen rates for hulless barley

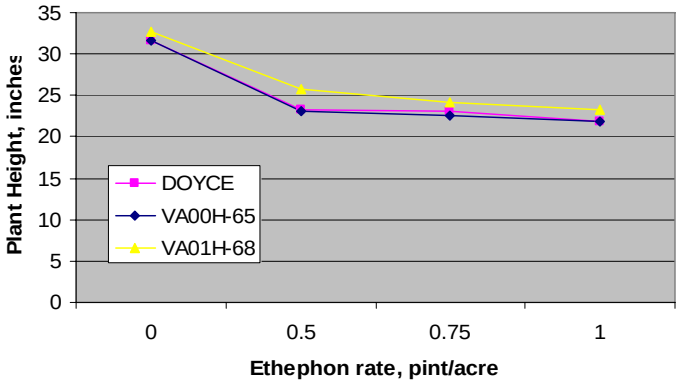
Timeline: Fall 2004 to Summer 2007

Trials were planted at the Eastern Shore AREC, Tidewater AREC, and the L.C. Davis & Sons Farm in New Kent County, in the fall of 2005. Rates of nitrogen ranging from zero to 180 kg N ha^{-1} were applied in different combinations in late winter and in early spring. No data will be collected until grain harvest.

Experiment: Lodging control in hulless barley

Timeline: Fall 2005 to Summer 2007

The released hulless barley cultivar 'Doyce' and experimental lines VA00H-65, VA01H-68 were planted at four locations in Virginia in fall 2005. Ethephon growth regulator was applied at rates of 0, 0.5, 0.75, and 1.0 pints $acre^{-1}$ to each cultivar to assess reduction in plant height and concomitant reduction in lodging. Across locations, 0.5 pints $acre^{-1}$ ethephon reduced plant height by 7.9 inches. Lodging and yield data will be collected at harvest.

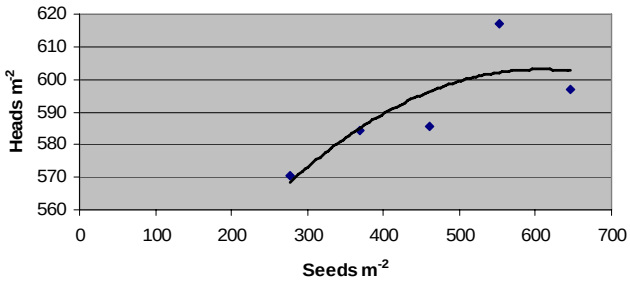


Project Component: Bread Wheat Management

Experiment: Bread Wheat Seeding Rate

Timeline: Fall 2004 to Summer 2007

Seeding rate trials were planted at the Tidewater AREC and at the Eastern Shore AREC in the fall of 2005. Plots were planted into conventionally tilled fields at rates of 278, 371, 464, 557, and 646 seeds m^{-2} at both sites. Germination, as determined by the VDACS lab, of all cultivars was high. All plants in 0.9 m of row from the two center rows of each plot were counted prior to the onset of tillering to determine the plant density achieved at each seeding rate. All heads in 0.9 m of row from the two center rows of each plot will be counted to determine heads per square meter in June, 2005, prior to harvest. Grain yield and yield components will be determined from the plots following harvest.



Effect of bread wheat seeding rate on fall plant stands.

Bread Wheat Disease Studies
Timeline: Fall 2004 to Summer 2007

One trial was planted at the Eastern Virginia AREC and one at the Eastern Shore AREC in fall 2005 to evaluate the necessity and effectiveness of fungal disease control in potential bread wheat cultivars. This trial was a featured stop on the Virginia Small Grain Grower's Association Annual Field Day held at the EVAREC on May 18, 2006. Approximately 150 attendees viewed the plots. One half of all plots received a seed application of Baytan® fungicide to limit fall infection of powdery mildew (PM), however fall and winter PM incidence was low at both locations so no fall disease evaluations occurred. An application of the recommended label rate of Quilt® fungicide was applied to predetermined plots in both trials at flag leaf emergence in the spring of 2006. For some plots, this control measure will be in addition to the Baytan®, while in others, it will be the only control. Both trials have been rated for disease severity this spring and these ratings are ongoing at the time of this report. Grain yield and yield components will be determined from the plots following harvest. Grain samples will also be evaluated for milling and baking characteristics to determine if disease or control measures affected grain quality parameters.

Carl Griffey displaying wheat cultivars at the VSGA Annual Field Day, EVAREC, May 19, 2006.

Summary of work yet to be completed:

Grain yield and yield components will be determined from all experiments following harvest which is expected to occur throughout June, 2006. Laboratory analysis of over 1000 barley and wheat grain samples for quality and end-use applications will occur shortly after harvest. Analysis of samples is a very costly event in this portion of the project; however it is likely the most valuable information will result. The funding from this grant makes the laboratory analysis possible.